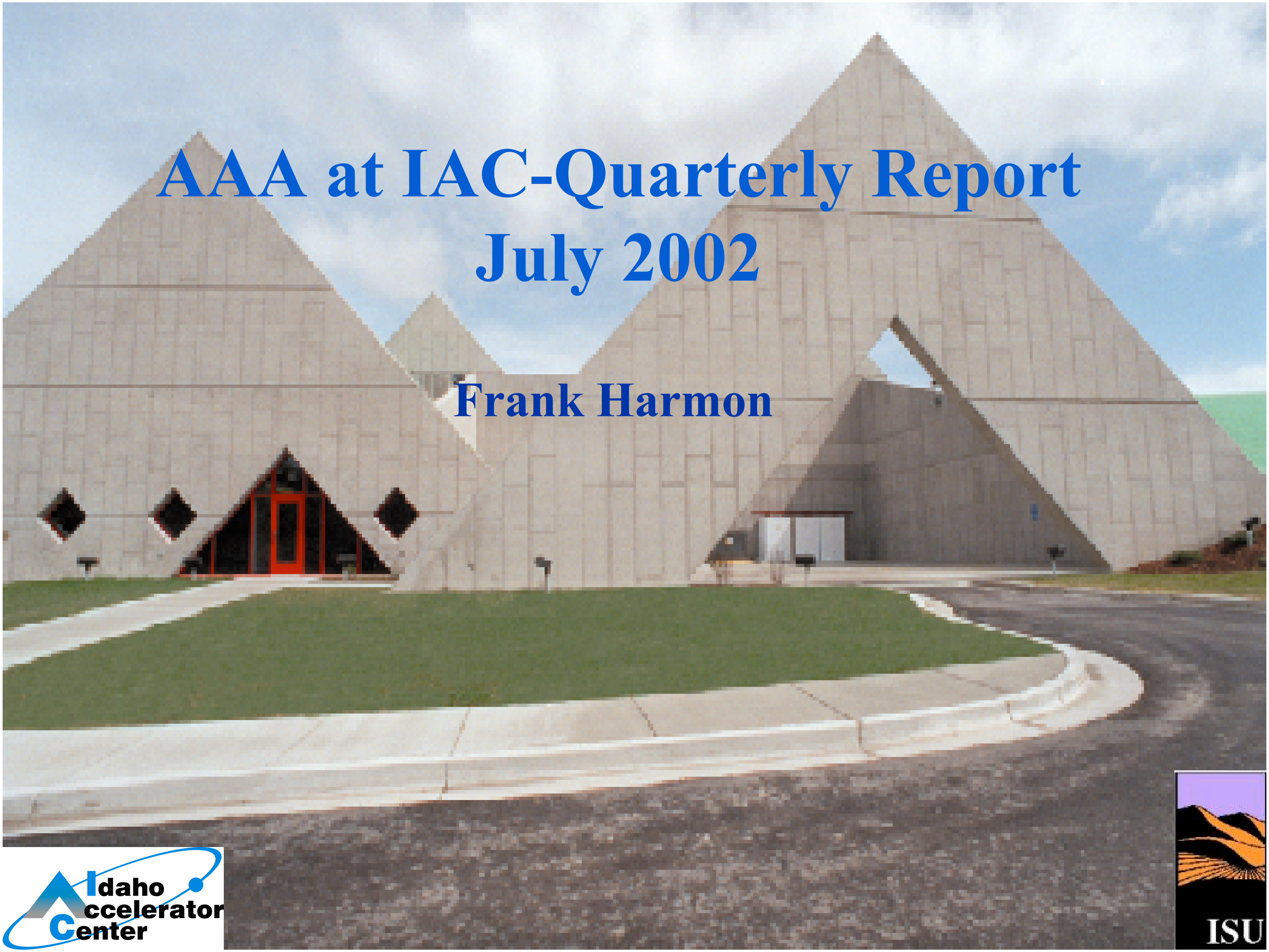
AAA at IAC-Quarterly Report
July 2002

Frank Harmon



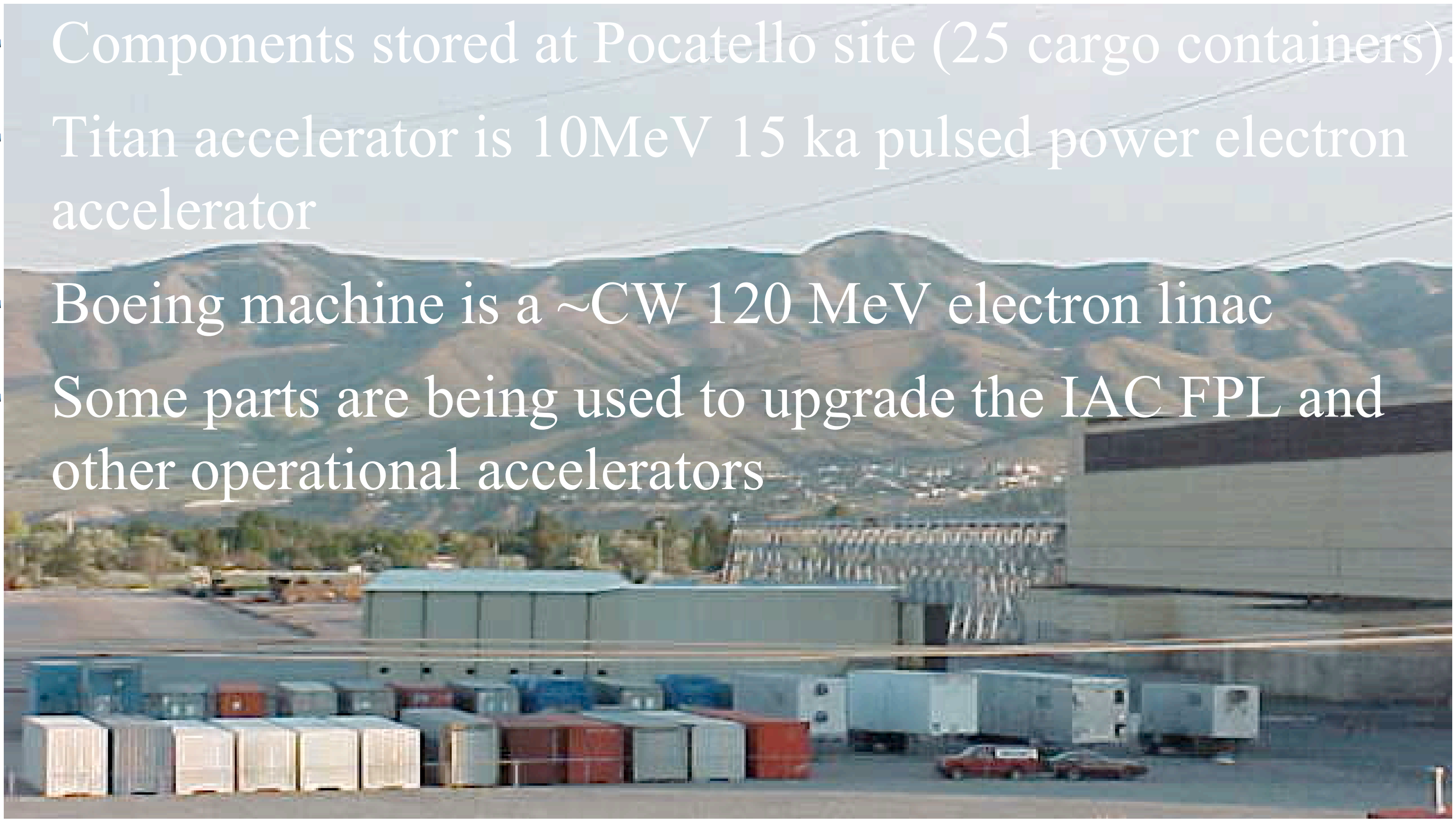
For This Quarter

- Acquire the Titan and Boeing accelerators.
- Begin calculations and benchmark measurements on neutron producing targets for sub critical accelerator coupling experiments.
- Begin positron stress measurements as applied to AAA materials, a UNLV collaboration.
- Continue dose conversion coefficients project with UNLV and FSU organizations.

Titan and Boeing Machines

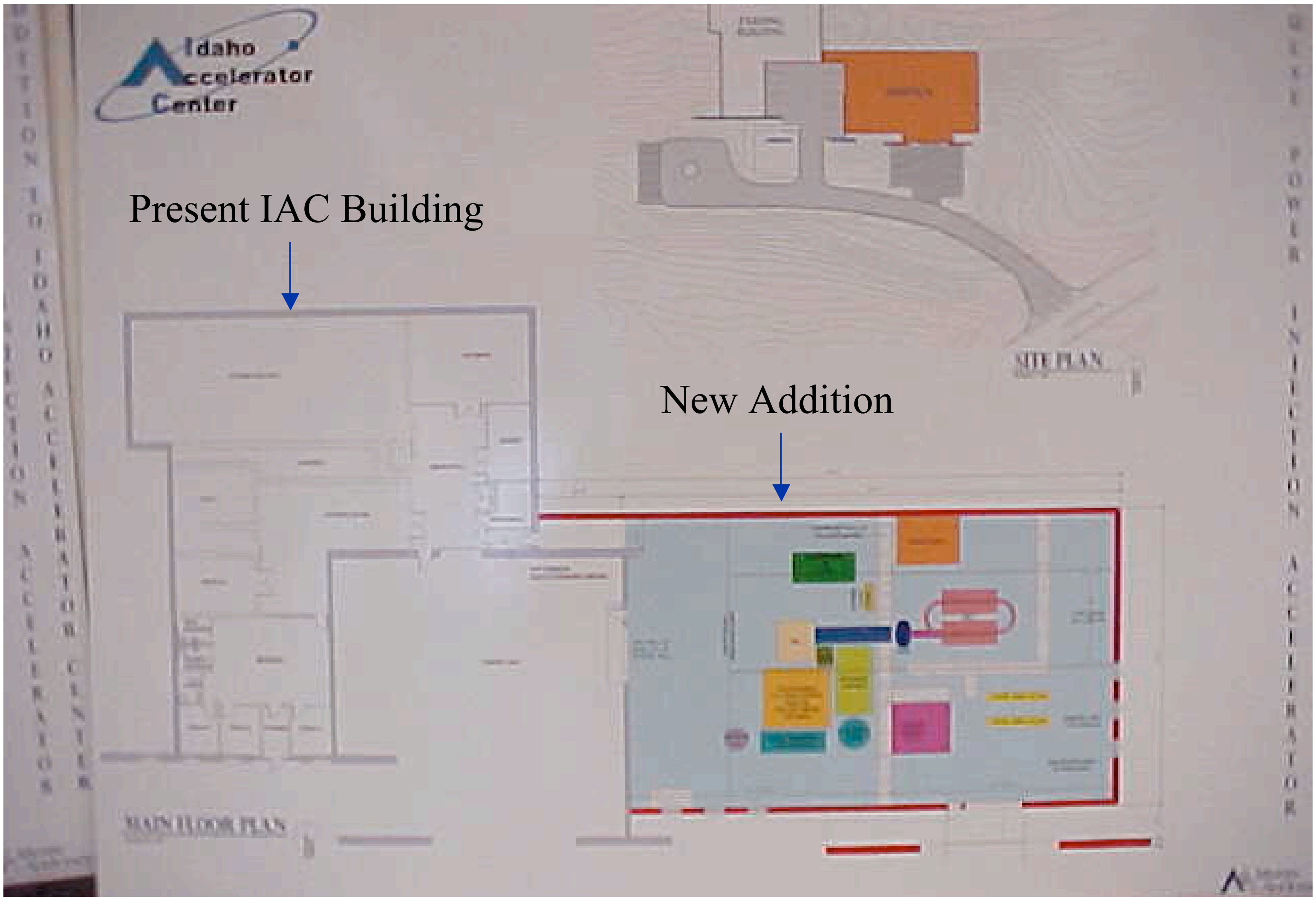
Former SDI test beds, donated to the IAC.

- Components stored at Pocatello site (25 cargo containers).
- Titan accelerator is 10MeV 15 ka pulsed power electron accelerator
- Boeing machine is a ~CW 120 MeV electron linac
- Some parts are being used to upgrade the IAC FPL and other operational accelerators



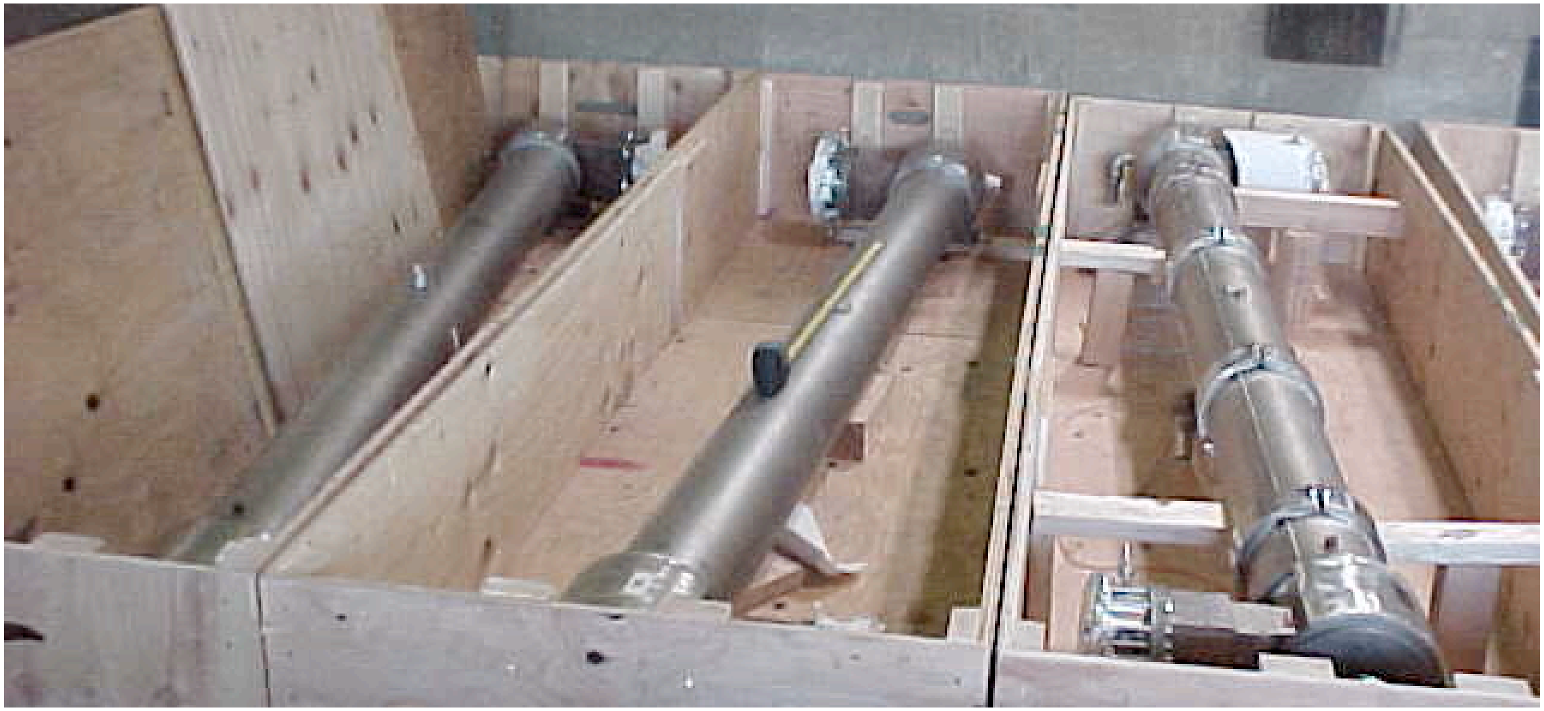
Building Addition for Titan Accelerator

ISIS 1&2 (construction in late summer)



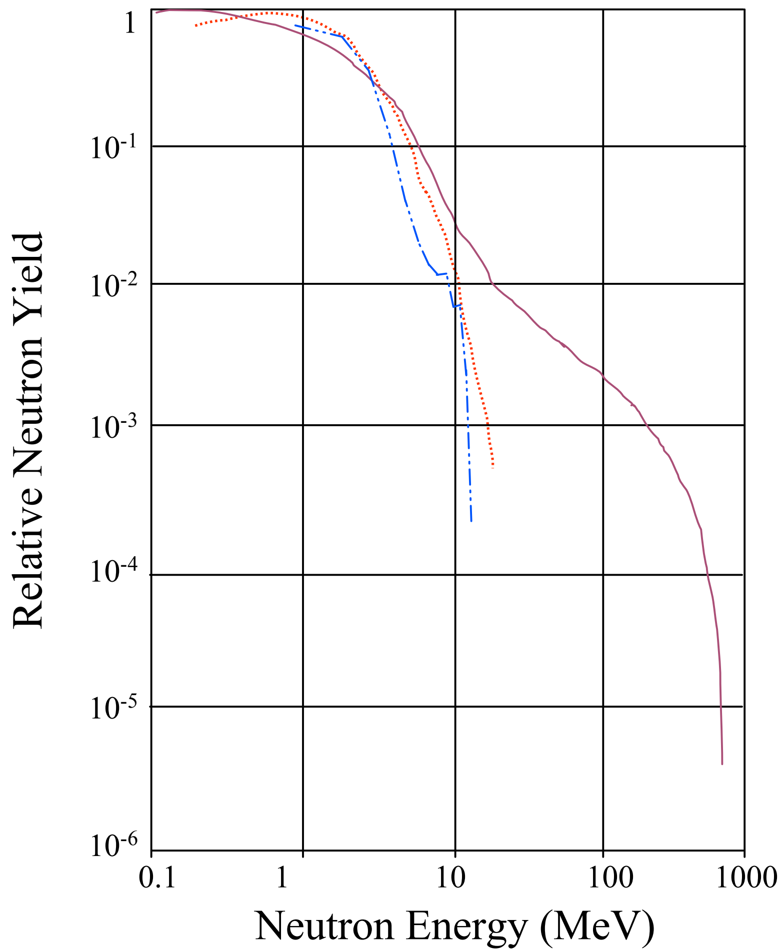
25 MeV L Band Accelerator Guides

One or more of these Boeing guides can be used for a neutron source driver accelerator



Neutron Spectra

In addition to being cost effective and reliable, electron linac neutron sources approximate the spectra from proton spallation sources.



Dotted – 100 MeV electrons on U target

Solid – 800 MeV protons on W target (LANL Spallation Source)

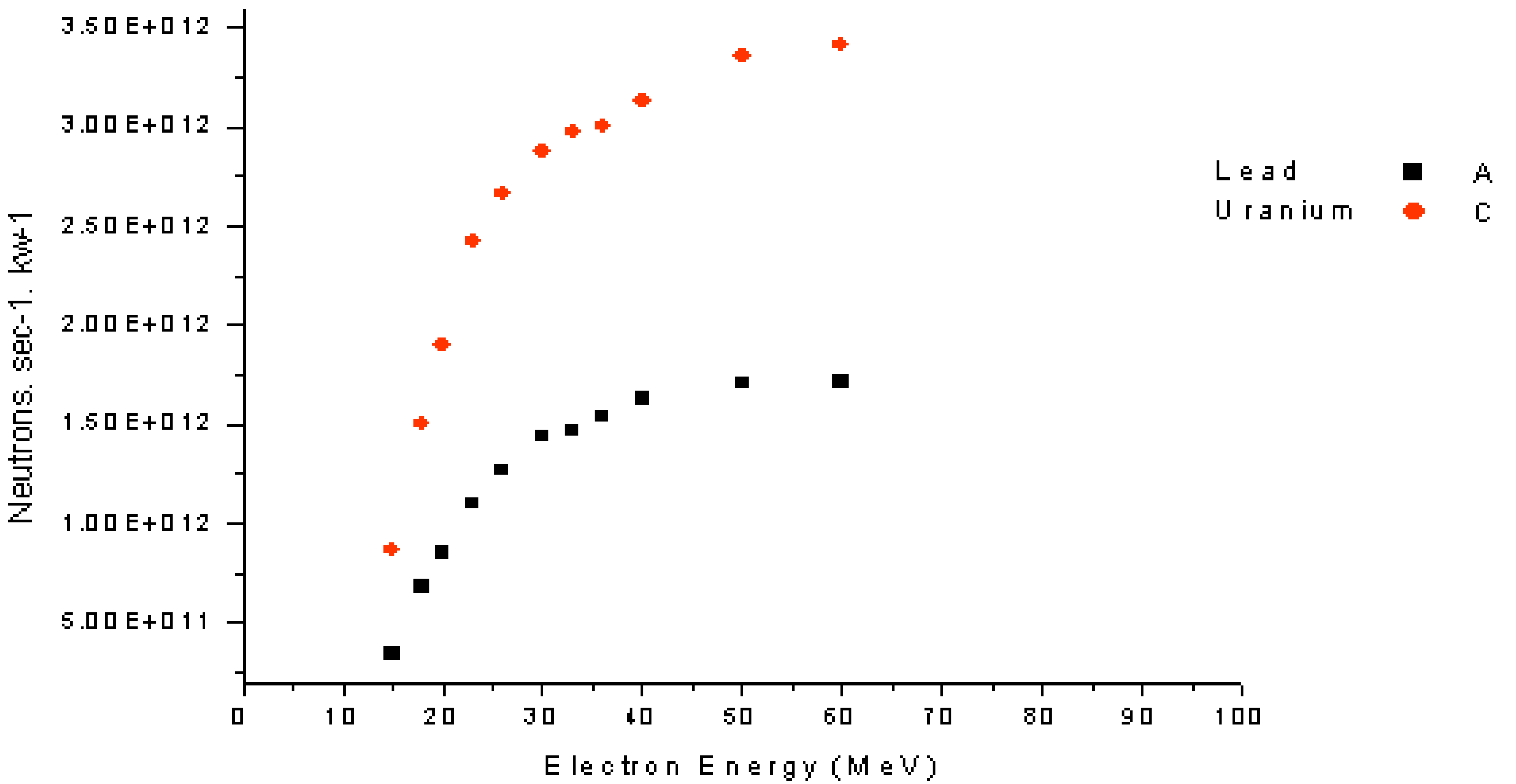
Dashed – 20 MeV electrons on Pb target

Benchmark Measurements

Lead cylinder target is ~ 2” x 4”. Neutron yield is determined using lead foils and gamma spectrometer.

Calculations for Neutron Yield

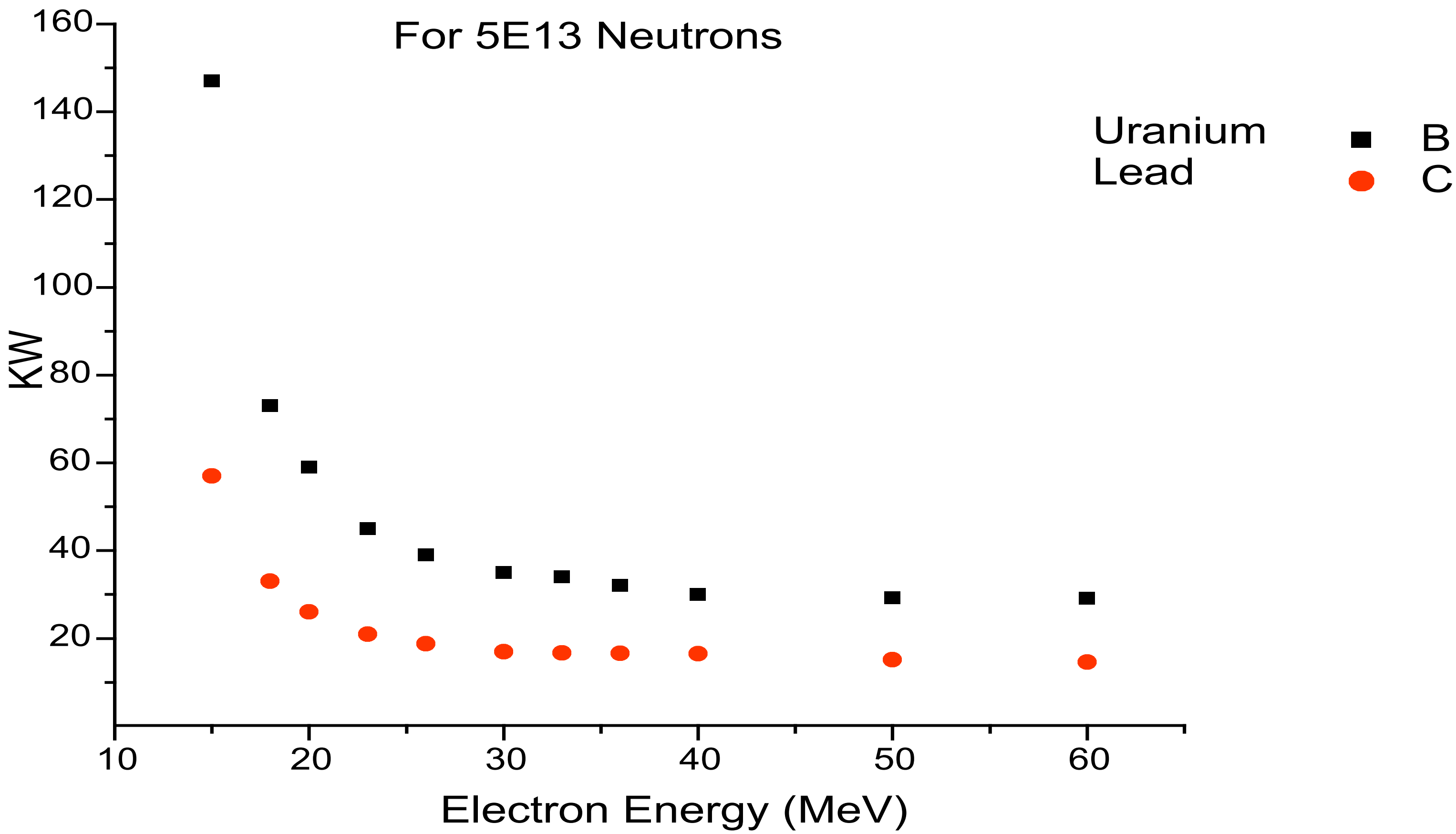
These calculations will be benchmarked with experiments now underway.



Optimum Accelerator Energy

Beam power vs. beam energy to generate 5e13 neutrons/sec.

Optimum energy looks to be ~ 30 MeV, balanced against increased size and complexity as energy is increased.



γ-ray induced positron annihilation spectroscopy (PAS)

Concept of the new technique:

- **Instead of using positron beam, we use a MeV γ-ray to bombard the material.**

- **MeV γ-rays penetrate deeply inside the material and create positrons via pair production.**

- **Annihilation of positrons produces 511 keV photons whose spectrum reflects the electron momentum in the material.**

Stress &Defect analysis by Doppler broadening

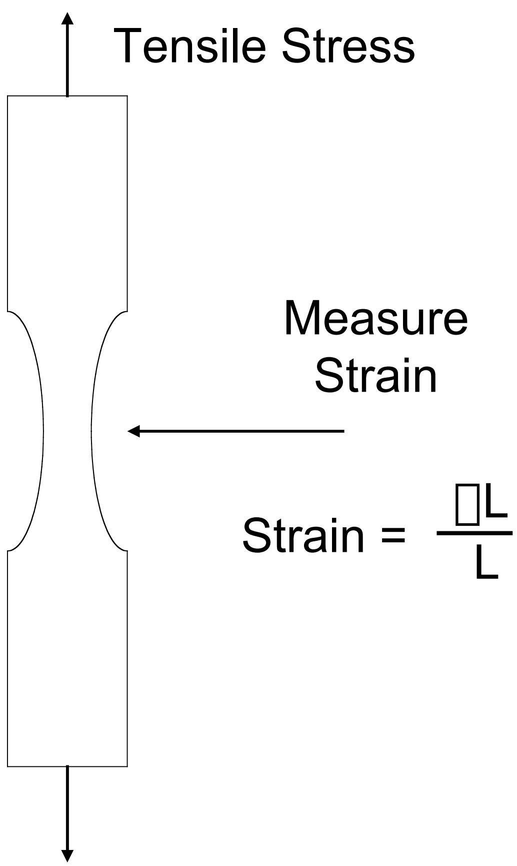
- **Defects in a material lead to a large contribution of annihilation photons from low momentum electrons- thus;**

  - **narrow peak**

  - **increase in the fraction of low momentum electrons in material**

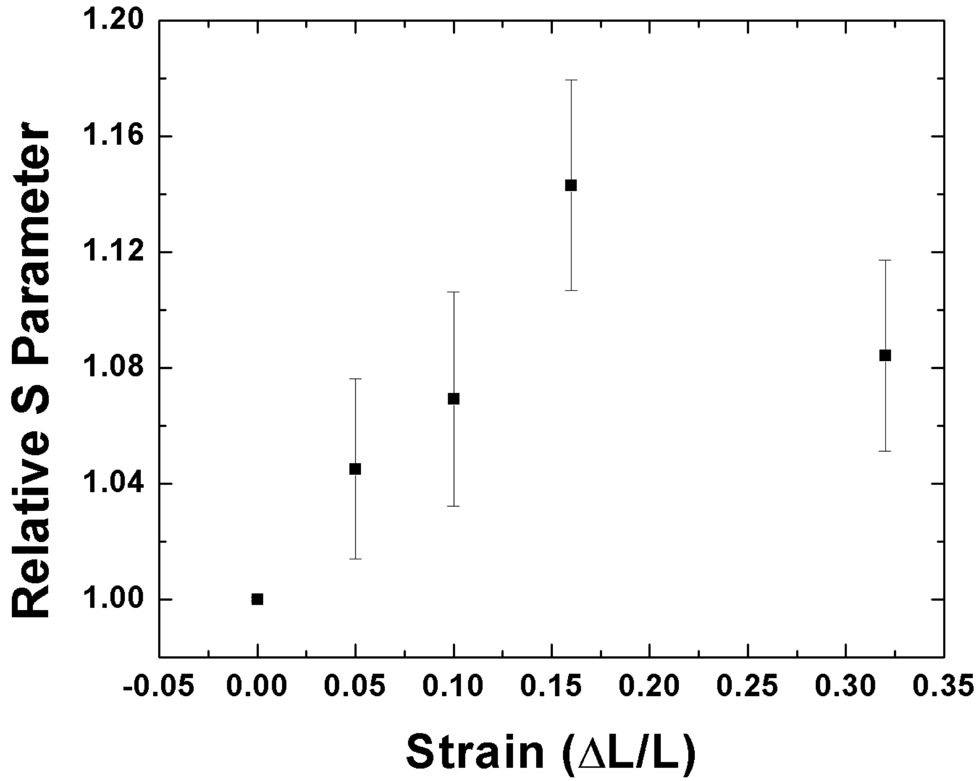
Stress/strain measurements in thick engineering materials

<u>Test Sample preparation</u>



- Different tensile loads applied to low alloy steels

Induced Strain reflected in the measured line width (S parameter)



Data point with greatest strain is from broken sample

Benefits as a Evaluation Tool

- High penetration of □-rays can assess bulk properties to predict failure etc.
- Defects can be investigated in very thick samples up to tens of gm/cm^2 (not available with other techniques).
- Simple and potentiality portable low cost technique.
- No radioactive materials.

Dose Conversion Coefficients

This is a collaboration with UNLV and Tbilisi University (FSU)

- Three students from Tbilisi now at ISU.
- Two meetings in Nevada with UNLV-ISU-Tbilisi team this past quarter.

AAA at IAC-FY 2003

1. ANL/ TREAT Coupled Reactor/Accelerator Experiments:
This continues the interaction with Argonne National Laboratory (ANL) to support the proposed coupled reactor/accelerator experiment at TREAT. Work in FY 2003 will begin tests of the accelerator for the TREAT experiment. Part of this work is to design and begun construction of an accelerator/sub-critical system on the ISU campus based on the ISU College of Engineering sub-critical assembly. This will provide an experimental and training resource for the AAA program.

2. Positron based stress analysis:
In FY 2003 materials from AAA collaborators at UNLV and LANL will be examined and information will be compared to other methods for analysis. In addition progress will be made in moving the technology to a truly portable system to enhance the utility of the process for in-field applications.

3. Using pulse power accelerator ISIS 1 for thermal stress testing:
The intense electron beam from the new IAC induction linac ISIS 1, obtained and deployed under the AAA program in FY 2002, can be used to do thermal stress testing of specific AAA materials such as accelerator window materials. The stopping power of few MeV electrons in materials is similar to that GeV protons.

4. Use of MEGS for radio nuclide transmutation:
Proof of principle experiments using mono energetic gamma ray beams from IAC's unique Compton –Backscatter facility (MEGS) will be undertaken to determine the feasibility of transmuting radionuclieds such as are found in nuclear waste.

Funding Request
To maintain the momentum of the work begun in FY2002 and to assure the continued development of the IAC as a unique resource for the DOE AAA program and other federal programs (DOE, DOD), the funding request for FY 2003 is $3,500,000.